Attachment 1

California Department of Fish & Wildlife - Follow up comments to the Fall 2012 workshops for the Phase 2 review and update to the 2006 Water Quality Control Plan for the San Francisco/Sacramento-San Joaquin Delta Estuary

The Department of Fish and Wildlife (CDFW), formerly the Department of Fish and Game (CDFG), appreciates the opportunity to have participated in the panels at your September, October, and November 2012 Phase II workshops on the comprehensive review and update of the 2006 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan). CDFW commends the State Water Resources Control Board (State Water Board) for its strategic approach to its update of the Bay-Delta Plan and its commitment to base its decisions on best available scientific information. As part of this process, the State Water Board has conducted a series of informational proceedings, technical workshops, and public meetings which have resulted in thousands of pages of written documentation, some of which has been prepared by State Water Board staff.

After reviewing the presentations and comments submitted by other trustee agencies and interested stakeholders, we have identified additional recommendations and technical information we respectfully provide to the State Water Board for its consideration in its review of the Bay-Delta Plan.

CDFW continues to support the biological and management goals in the State Water Board's 2010 report titled *Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem* (2010 State Water Board Flow Criteria Report)[1]. To meet these goals, we strongly encourage the use of CDFW's 2010 report titled *Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta* (2010 CDFW Flow Report)[2] to establish a range of flow criteria for the Delta.

In the course of the workshops for Phase II, CDFW, U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and the U.S. Environmental Protection Agency (USEPA) have individually submitted comments and participated in the Fish Agency Panel presentations to provide new and additional information that continues to support CDFW's flow recommendations for species of concern that are dependent on Delta flows.

We have reviewed stakeholder comments, some of which suggest that there is insufficient scientific evidence for modifying the exiting flow criteria. Our review found that the evidence presented does not substantiate a change to our position that the State Water Board should establish new flow objectives that support the goals and

[1] State Water Board. 2010a. Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem. August 3, 2010. pp.43-44.

[2] CDFG. 2010b. Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta. Sacramento, CA.

biological objectives identified in its 2010 State Water Board Flow Criteria Report.

In this letter, CDFW first provides recommendations that the State Water Board should consider when evaluating the best available science and scientific credibility. Secondly, we address information presented by stakeholders that suggest that the existing scientific information do not support establishing new tributary inflow and Delta outflow objectives, and provide additional comments on other topics that touch upon our flow recommendations. In addition, we provide additional recommendations that the State Water Board should consider in designing an adaptive management plan equipped to address changing circumstances. Finally, CDFW concludes by encouraging the State Water Board to focus on flows in its Bay-Delta Plan update.

I. Best Available Science

The objective of this section of our letter is to give guidance to the State Water Board on how to evaluate the vast record of information collected during its proceedings for updating the Bay-Delta Plan. To accomplish this objective, we first describe criteria for best available science and scientific credibility. We then highlight key reports and input from key scientific and technical experts that we believe provide a solid scientific foundation for the State Water Board's strategic approach to updating the Bay-Delta Plan.

Criteria for Best Available Science and Scientific Credibility

The 2009 Delta Reform Act requires the Delta Stewardship Council to use best available science in implementing its Delta Plan.[3] We believe the Delta Plan criteria for best available science is a useful framework that the State Water Board can use while evaluating the weight of scientific information it has received for the review and update of the Bay-Delta Plan. The criteria for *best available science,* which were largely based on Sullivan et al. (2006), are:

- Relevance
- Inclusiveness
- Objectivity
- Transparency and openness
- Timeliness and
- Peer review

The Delta Plan also includes a generalized ranking of *scientific credibility*, which was adapted from criteria Sullivan et al. (2006). Beginning with the most rigorous category, these criteria are as follows:

1. Independently peer-reviewed publications including scientific journal publications and books;

[3] Appendix A of the Final Draft Delta Plan (Delta Stewardship Council 2012).

2. Other scientific reports and publications;
3. Science expert opinion; and
4. Traditional knowledge.

The State Water Board has the enormous task of evaluating thousands of pages of scientific and technical information that it has received from state, federal and local agencies and non-governmental organizations. This information has been submitted as part of the public scoping process for preparation of environmental documents to support the Bay-Delta Plan update, including three informational workshops on various technical issues in late 2012 and during informational proceedings that occurred in 2010.

Key Reports with Solid Scientific Foundation

The State Water Board anticipated the Bay-Delta Plan update in its 2008 Strategic Work plan and initiated on August 29, 2008 its periodic review of the 2006 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary by issuing a notice of public workshop to solicit input on potential modifications to the Bay-Delta Plan.

In August 2009, the State Water Board produced a staff report on the *Periodic Review of the 2006 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (State Water Board 2009). The staff report was based on a review of scientific literature and relevant information and includes a discussion of scientific issues that were recommended by staff to be addressed in the water quality planning process.

In August 2010, the State Water Board produced its 2010 State Water Board Flow Criteria Report, which was the culmination of several days of expert panel deliberations on flow criteria (particularly Delta outflow) necessary to protect public trust resources. Flow criteria in the 2010 State Water Board Flow Criteria Report were based on best available scientific information submitted during the multi-day proceeding on unimpaired flow conditions, ecological functions and statistical relationships between flow and native species abundance. We agree with one of the fundamental conclusions in this report that flow and physical habitat interact in many ways but are not interchangeable and that the best available science indicates that current flows are insufficient to protect public trust resources.

In October 2010, the State Water Board released its first draft of a report titled *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives* (Technical Report)[4]. The Technical Report was prepared to provide the State Water Board with the scientific information and tools necessary to inform potential changes to the San Joaquin River flow and southern Delta water quality objectives, which is Phase I of the Bay-Delta Plan update.

[4] State Water Board 2010b

The Technical Report underwent an independent scientific peer review in fall 2011, including review by scientists from the Oakridge National Laboratory and University of Washington (UW). A key point made by Dr. Julian D. Olden of UW is that *"The assumption is made [in the Technical Report] that present-day hydrographs that aim to mimic unimpaired hydrographs represent more "natural" conditions that favor the life-histories of Chinook salmon and steelhead trout in the San Joaquin River basin. This assumption is both well defended in the Technical Report and by decades of scientific research conducted in California and elsewhere."*[5] The Technical Report was subsequently revised in February 2012, and again in December 2012.

In May 2012, the Delta Independent Science Board provided a memorandum to the State Water Board stating that the Technical Report *"makes a persuasive case that fish and wildlife need more flow and more natural spatial and temporal patterns of flow. The report's external scientific reviewers, who endorsed these conclusions, are respected and experienced scientists with extensive expertise in salmonid biology, and they provided a thorough review of the report."*[6]

In summary, it is our opinion that the State Water Board is using a credible and transparent process to update the Bay-Delta Plan and is also incorporating best available science into its key reports. These reports contain scientifically well-substantiated and documented information that is foundational to the Bay-Delta Plan update. It is our opinion that these reports provide a sound scientific basis for the State Water Board to establish flow objectives to protect beneficial uses identified in the Bay-Delta Plan. In addition, the State Water Board has used an open and transparent process to gather public input on the Bay-Delta Plan update, including the use of focused scientific and technical workshops and independent scientific peer review.

Input from Scientific and Technical Experts

Three scientific/technical workshops for the comprehensive review and update of the Bay-Delta Plan were held during the September to November 2012 time period. The proceedings of these workshops are summarized in a January 2013 report titled *Comprehensive (Phase 2) Review and Update to the Bay-Delta Plan: Draft Bay-Delta Plan Workshops Summary Report* (Workshops Summary Report)[7]. The workshops were attended by a diverse group of public agencies, NGOs, stakeholders and the general public.

Each of the workshops included an invited panel of scientific and technical experts. Several of the most highly regarded experts on the San Francisco Bay-Delta estuary participated on these expert panels. We recommend the State Water Board give special deference to the invited panel member's expert opinion and written

[5] Olden, J.D. 2011, p. 3
[6] Delta Independent Science Board 2012, p. 2
[7] ICF International. 2013. Comprehensive (Phase 2) Review and Update to the Bay-Delta Plan: Draft Bay-Delta Plan Workshops Summary Report. Prepared for State Water Resources Control Board. Sacramento, CA.

submittals with particular weight given to panel members having a record of peer-reviewed published journal articles on the Bay-Delta estuary. Similarly, we recommend the State Water Board give weight to peer-reviewed publications.

CDFW, USFWS and NMFS (the fish agencies) participated in these scientific/technical workshops as well. Participants from these agencies are also some of the most highly regarded scientific experts in the San Francisco Bay-Delta estuary that have a record of peer reviewed publications. Given the public trust responsibilities of the fish agencies, we recommend that you consider this input carefully as you sort through and evaluate input by various stakeholders.

The State Water Board has received a substantial number of written submittals, exhibits, and oral presentations as part of the public process to update the Bay-Delta Plan. The Workshops Summary Report describes key points of agreement, disagreement, uncertainties and questions which should be very useful to the State Water Board. We suggest however, that disagreement does not necessarily constitute a credible scientific debate and that the State Water Board consider the criteria described above, to evaluate the information received and ensure that only the best available science is used to inform decision making processes.

II. Additional Information Addressing Stakeholder Comments

Tributary Inflow

Tributary inflows influence several factors vital to the life history needs of salmonids in the Delta and beyond. These factors include the availability of floodplain habitat, suitable water temperatures, and magnitude and timing of flows through the Delta. Inflows provide appropriate conditions to cue upstream adult migration and holding, egg incubation, juvenile rearing, provides attraction flows, outmigration flows and other functions (CDFG 2010b, p. 45-47). In addition, flows directly affect juvenile survival and abundance, as decreased flows may reduce downstream migration rates, increasing their exposure time to unsuitable water temperatures, entrainment into the interior Delta, contaminants, and predation (CDFG 2010c, p. 2). Flows affected by Delta Cross Channel gate operations also influence migration, survival, and stray rates. Providing appropriate inflows to increase salmonid survival through the Delta will be a critical step toward restoring natural production of salmonids in the Central Valley.

Spring flows in the San Joaquin River Tributaries

CDFW previously provided recommendations for spring flows in the San Joaquin River (CDFG 2010e), and continues to support the use of natural flow regime based flow criteria for the Delta's tributaries. In snow-melt driven systems such as the San Joaquin, natural flows fluctuate due to direct rainfall runoff from occasional early and warm mid-winter storms, though large snowmelt runoff occurs in April, May and June in nearly all years. In order to capture this intra and inter year variability, CDFW supports the method of basing required flows on the average unimpaired flows over as few days as practical (CDFG 2011a). We believe variable flow patterns will best restore and maintain conditions that meet salmonid biological requirements.

In comments submitted for Workshop 2, the San Joaquin Tributaries Authority (SJTA) asserts that the State Water Board's 2012 Technical Report's conclusion that higher spring flows result in increased adult abundance is based on flawed analyses that are not the best available science and should not be used as primary justification to modify flow objectives (Demko et al. 2012a). These stakeholders assert these analyses do not adequately account for variables other than flow that could affect smolt survival or adult escapement, and that some references have not been peer-reviewed (see CDFG 2005; CDFG 2010d; Mesick et al. 2007; Mesick 2009). Their assertion is based on flawed analyses of the CDFW San Joaquin River Salmon Model V.1.6 (Salmon Model V1.6), an early and less comprehensive model than the SALSIM model that is nearing public release. CDFW and the modeling team has continued to improve the model by incorporating comments from two peer review processes and by utilizing an Advisory Committee, in which the SJTA declined to participate. These stakeholders do not understand that these analyses do account for variables other than flow that affect smolt survival or adult escapement, as discussed at Workshop 3. CDFW uses the best available science, which prioritizes peer-reviewed literature, but in no way excludes agency reports and other relevant sources of data and materials.

CDFW continues to believe that the State Water Board Technical Report (2012) relies on the best available science. The hydrology of the San Joaquin River system has been altered significantly from the natural regime (State Water Board 2010a). Altered flow regimes have resulted in discrepancies ranging from 11% to 31% of historical unimpaired flow. In addition, a shift in the highest peak flow period, as indicated for the San Joaquin River (State Water Board 2010a); can have significant effects on the anadromous fish populations (Fleenor et al. 2010; Yarnell et al. 2010). Substantial reduction in spring flow magnitude, duration, and frequency has had unmitigated significant impacts upon anadromous fish populations in San Joaquin River tributaries (CDFG 2010a; USFWS 2001). We have shown in earlier submittals that late winter-spring flow magnitude, duration, and frequency are intricately tied to improved juvenile salmon rearing conditions and population abundance (CDFG 2010f).

Flows in the Sacramento River watershed

The Bay-Delta Plan includes flow objectives for the Sacramento River at Rio Vista for the protection of fish and wildlife beneficial uses from September through December (State Water Board 2006). These objectives range from 3,000 to 4,500 cubic feet per second (cfs) and are in part intended to provide attraction flows, outmigration flows and suitable habitat conditions for Chinook salmon (CDFG 2010b). The Bay-Delta Plan does not include any specific Sacramento River flow requirements for the remainder of the year, including the spring. However, smolt survival increased with increasing Sacramento River flow at Rio Vista, with maximum survival observed at or above about 20,000 and 30,000 cfs from April through June (CDFG 2010b). This relationship did not exist at flows between 7,000 and 19,000 cfs, suggesting a potential threshold response to flow (CDFG 2010b). Juvenile Chinook salmon outmigration on the lower Sacramento River near Knights Landing also indicates a relationship between timing and magnitude of flow in the Sacramento River and the migration timing and survival of Chinook salmon approaching the Delta from the upper Sacramento River basin (Snider and Titus 1998, 2000a, b, c). Pulse flows in excess of 15,000 to 20,000 cfs may also be necessary to erode sediment in the upper Sacramento River downstream of Shasta to create turbid inflow pulses to the Delta that hide young salmon from predators (State Water Board 2010a).

The Sacramento Valley Water Users, Glenn-Colusa Irrigation District, and Northern California Water Association (collectively referred to as SVWU) are concerned that information in the State Water Board's 2009 Staff Report and 2010 Delta Flow Criteria Report are incomplete and out of date, misinforming the State Water Board regarding the current status of programs to restore anadromous salmonids. According to the SVWU these reports do not reflect the existing flow standards currently developed to benefit Sacramento River basin anadromous salmonids. The Department of Water Resources (DWR) believes increased flows have little effect on habitat availability due to the trapezoidal geometry of the Sacramento River channel and other Delta channels.

CDFW presented the best and most recent available science at the fall 2012 Phase II workshops, which addresses the concerns raised by SVWU and DWR. Based on existing reports and new information, CDFW still believes increased flows in the Sacramento River watershed are needed to inundate flood plain habitat, provide main channel downstream transport, rearing habitat, and increased food production for out migrant fry and rearing juveniles (CDFG 2010b). Salmonids respond behaviorally to variations in flow. Juvenile and adult anadromous salmonids begin migrating during the rising limb of the hydrograph (CDFG 2010b). Increased flows in the Sacramento River main channel are needed to transport smolts through the Delta to the ocean (CDFG 2010b). It is critical to understand how riverine ecosystems are affected by changes in parameters such as the frequency, magnitude, timing, duration, and rate of change of flow in order to make effective management decisions (Poff et al. 1997). To provide a balanced flow regime that meets the needs of all species, habitat types, and/or natural ecological processes, a multi-species and habitat approach, or using guilds, is required to better ensure that flow management is not driving a species or habitat type inadvertently into extinction. The CDFW continues to recommend that tributary and mainstem Sacramento River instream flows be assessed in a comprehensive manner using the best and most recent available science to ensure that a balanced flow regime is established and maintained that meets the needs of all species, habitat types, and/or natural ecological processes.

Floodplain activation and fluvial processes

In the 2010 CDFW Flow Report, CDFW recommended biological objectives to benefit salmon smolt rearing in the Delta, and includes providing floodplain inundation flows for at least 10 consecutive days between January and May during above normal and wet years and maintaining continuous floodplain inundation for at least 30 days in the Yolo Bypass and other suitable locations in the Sacramento and San Joaquin Rivers (CDFG 2010b). One of the goals, as outlined in the CALFED ERP-Stage 1 Report (CALFED 2000), is to help reestablish floodplain inundation and channel-floodplain connectivity with sufficient frequency, timing, duration, and magnitude to support the restoration and maintenance of functional floodplain, riparian, and riverine habitats. Studies on Yolo Bypass (Henery et al. 2010; Sommer et al. 2001) and Cosumnes River floodplains (Jeffres et al. 2008) have found higher growth rates for fish rearing on seasonally inundated floodplain habitat compared to main river channel habitat. CDFW believes that floodplain inundation can significantly improve growth and survival rates of juvenile salmon rearing in the Delta (CDFG 2010b, d).

SJTA commented that large, contiguous, shallow-water floodplain habitat to benefit Chinook salmon rearing does not exist nor can be created through flow management alone in the San Joaquin Basin, and that only floodplain habitat in the Sacramento River Basin has a positive effect on salmonid rearing. Further, the SJTA states that levee and bank protection structures along the San Joaquin River, Sacramento River and the Delta result in restrictions to the natural flow regime and floodplain inundation, making habitat restoration and species recovery efforts extremely difficult, and sometimes impossible. Although the SJTA agrees that floodplain habitat may improve the size and weight of Chinook outmigrants, SJTA claims there is no evidence that it increases abundance or that it is beneficial for adult recruitment.

CDFW recommends using best available science to determine the effects of inundated floodplains on salmonid rearing and nutrient input to riverine systems. Mesick et al. (2007) discusses the association of magnitude, timing and duration of flows and connectivity with riparian and floodplain habitat for successful salmonid rearing. CDFG (2010d) discusses in detail how the high productivity of floodplains is largely attributed to a nutrient rich environment that has significant benefits on juvenile rearing habitat for salmon. Floodplains contribute nutrients to the systems by releasing dried and mineralized nutrients from previously receded floodwaters (Bailey 1995), and seasonally inundated shallow water floodplains provide more productive habitat than main river channel habitat for juvenile salmonids (Williams 2006). Juvenile salmon will rear on seasonally inundated floodplains when available (CDFG 2010b), and floodplain rearing habitat allows juvenile salmon to grow faster and larger, which helps with outmigration, predator avoidance and ultimately higher survival rates (Stillwater Sciences 2003). A flow restoration project currently being conducted on the lower portion of Clear Creek, a tributary to the Sacramento River, provides flow discharges of sufficient magnitude, duration and frequency, with appropriate timing to create and maintain native floodplain and riparian vegetation, and is intended to recover and sustain anadromous salmonids (Stillwater Sciences 2008). This is an example of a project based on the best available science today and will aid in further evaluating the effects of inundated floodplain on salmonids.

Water temperature

For mainstem rivers that flow into the Delta estuary and their tributaries, CDFW recommends maintaining water temperatures and dissolved oxygen at levels that will support adult migration, egg incubation, smolting, and early-year and late-year juvenile rearing at levels that facilitate attainment of specified life-history stage production goals (CDFG 2010a, 2010b). The USEPA salmonid temperature criteria establish maximum (7-day average of the daily maximum) temperatures needed to protect a population (USEPA 2003).

In comments submitted for Workshop 2, the SJTA make several statements regarding water temperatures. They assert that water temperatures in the San Joaquin River and South Delta are controlled by air temperatures, and that reservoir releases will not impact water temperatures in the San Joaquin River or South Delta. In addition, they state that San Joaquin River restoration flows will adversely affect water temperatures downstream of the confluence with the Merced River. The SJTA also maintains that it's uncertain that salmon and steelhead survival benefits from releasing water to reduce temperatures in the tributaries (Demko et al. 2012a).

Despite these stakeholder assertions, it is well documented that increased flows can decrease water temperatures (CDFG 2011a; Constanz 1998; Mesick 2009). Sub-lethal water temperatures that exceed optimal temperatures contribute to the ongoing decline of fall-run Chinook salmon and steelhead by inducing adult pre-spawning mortality, and reducing egg viability, juvenile survival and smolt-outmigration survival (Myrick and Cech 2001). CDFW recommends that the State Water Board continue to explore the effects of potential flow-setting requirements on downstream water temperatures, and suggests further water temperature analyses using models such as the San Joaquin River Basin HEC-5Q Water Temperature Model (CALFED 2009).

Flow timing and magnitude

CDFW continues to recommend sufficient water flow be provided to transport salmon smolts through the Delta during the spring in order to contribute to the attainment of the salmon protection water quality objective of doubling the natural production of Chinook salmon from the average production of 1967-1991 (State Water Board 2006, table 3, p. 14). To benefit salmon smolts rearing in the Delta, CDFW recommends providing floodplain inundation flows during above normal and wet years for at least a 10 consecutive day period between January and May, and maintaining continuous inundation for at least 30 days in the Yolo Bypass and at suitable locations in the Sacramento or San Joaquin Rivers (CDFG 2010b).

Salmon migration can be temporarily stimulated through flow management, but the SJTA suggest that pulse flows may not improve fry/smolt survival (Demko et al. 2012a). The SJTA also state that migration rate and timing are not dependent on flows; however this assertion was based on Mesick (2001), which presented conflicting results due to uncertainties and data limitations, and Pyper et al. (2006), which conversely found migration timing was stimulated by increases in flow, and was cited incorrectly.

The magnitude, duration, timing, and source of inflows have significant effects on Chinook salmon migrating through the Bay-Delta system (Allen and Titus 2004; CDFG 2010b; Kjelson et al. 1981). Emigration monitoring provides evidence of a relationship between the magnitude of flow in the Sacramento River and the migration timing and survival of Chinook salmon approaching the Delta from the upper Sacramento River basin (Snider and Titus 2000c). Emigration timing is dependent upon substantial increases in river flow through the lower Sacramento River in the fall (Allen and Titus 2004). Reduced smolt survival is associated with decreases in the magnitude of flow through the estuary, increases in water temperature, and water project diversions in the Delta (USFWS 1987).

Delta Cross Channel Gates

As noted in our September 20, 2012 Workshop 2 letter, CDFW recommends modifying the objectives for Delta Cross Channel (DCC) gate operations in the Bay-Delta plan to be consistent with the NMFS 2009 Biological Opinion (BO) with 2011 amendments (CDFG 2012b). As explained in our letter, we also recommend that the State Water Board include DCC gate operation modifications to allow for flexible DCC gate closures for up to 14 days for pulse flow experiments in October, which could potentially improve migratory cues for both Sacramento and Mokelumne River origin fall-run Chinook salmon (NMFS 2009).

DCC operations have been identified as a key influence on Delta hydrology along with fish behavior and survival (U.S. Bureau of Reclamation (USBR) 2012a). With the DCC gates open, there is a clear pathway for adult salmon migrating upstream into the Lower Mokelumne River to stray into the Sacramento River system (USBR 2012a). DWR agrees that survival rates are lower among fish exposed to diversion at the DCC (Stein 2012a). Vogel (2012), on behalf of the Sacramento Valley Water Users, Glenn-Colusa Irrigation District, and Northern California Water Association, recommends the State Water Board consider a structural solution to resolve adult salmon blockage.

Preliminary results of previous seasonal temporary closures in the Mokelumne River may indicate that having the DCC closed during a portion of October would strengthen migration cues for fish, including Chinook salmon (USBR 2012a). The proposed operational criteria are designed so that the impacts to water quality would be *de minimus*, as the closure would be timed in accordance with current conditions so that no water quality objectives would be exceeded (USBR 2012a). The State

Water Board Decision 1641 and the 2009 NMFS BO include language that encourages USBR to participate in hydrodynamic, water quality, and fishery experiments that may have benefit to special status species in cooperation with other agencies, such as the Mokelumne Joint Settlement Agreement Partnership.

Delta Outflow

Delta outflow is a major driver of habitat condition in the Bay-Delta Estuary. Through its influence on the position and extent of the low salinity zone (LSZ) and the downstream transport of larval and juvenile life stages, adequate Delta outflow is critical in protecting and recovering fish and wildlife species populations. Sacramento River and San Joaquin River flows and exports are the primary controlling factor for outflow. Salinity of ocean water is considered constant though climate change is expected to erode this assumption over time. And although the Bay-Delta Plan focuses on protection of pelagic species in the LSZ, it is important to note that Delta outflow also benefits marine-oriented species downstream of the Delta.

Utility of X_2 as an outflow objective

Although the position of X_2 (the position of 2% bottom salinity in the estuary) is a convenient index of Delta outflows for managing the LSZ, it is not a perfect indication of habitat suitability for estuarine species. For example it does not account for upstream tributary flow needs of fish and wildlife or manage entrainment/salvage at the export pumps. However, it serves the purpose of ensuring the presence of key physical components of habitat for estuarine species in the estuary.

Comments from the Sacramento Valley Water Users (SVWU) and Northern California Water Association (NCWA) noted that there are other factors other than outflow that contribute to species abundance and asserted that the underlying relationship between increased flows and delta pelagic fish species abundance is uncertain, and that the mechanisms that produce the correlations between X_2 and abundance of pelagic species are not fully understood (Bourez 2012a). These commenters believe the State Water Board should not set flow standards because the relationship is not yet quantified or that addressing flows will not be sufficient in addressing species abundance.

The best available science, however, demonstrates persistent and strong positive correlations between outflow, particularly spring outflows and the abundance of many aquatic species (Mac Nally et al. 2010; Thomson et al. 2010) and there are many plausible flow-related mechanisms that can explain these associations. Several credible potential mechanisms underlie the longfin smelt abundance– X_2 model (Kimmerer et al. 2009). These include increased low salinity habitat, larval transport, turbidity, and food supply. CDFW believes that addressing other non-flow factors without first addressing flows will not lead to species recovery. Previous studies during periods of low outflow show poor and declining species abundance despite the full range of other non-flow factors involved (Kimmerer 2002b). While ongoing and future studies, such as the pelagic organism decline investigations and the studies associated with Fall Low Salinity Habitat adaptive management, may reduce uncertainties of outflow and its effect and mechanisms that influence species abundance; current science indicates that the benefits are likely strong and mechanistic, and that estuarine habitat can be protected through use of X_2 as an outflow objective.

Pelagic Species and Delta Ecosystem Health

The delta smelt (*Hypomesus transpacificus*) is listed as threatened under the Federal Endangered Species Act (FESA) and endangered under the California Endangered Species Act (CESA) and longfin smelt (*Spirinchus thaleichthys*), listed as threatened under CESA, is at the risk of extirpation from the San Francisco estuary. The abundance of both species has declined dramatically in recent decades. To increase the abundance of these and other species, more Delta outflow is needed than what the current Bay-Delta Plan provides. Delta outflow is one factor that can be regulated by the Bay-Delta Plan and water operators to have a significant influence on pelagic species abundance. Kimmerer (2002a, 2004) indicates that many San Francisco Estuary species respond positively to freshwater outflow. Longfin smelt abundance experienced the greatest influence from winter and spring outflows (Jassby et al. 1995; Sommer et al. 2007; Stevens and Miller 1983; Thomson et al. 2010).

Comments from the State Water Contractors (SWC) and San Luis and Delta-Mendota Water Authority (SLDMWA) suggest factors other than just flow need to be addressed for species survival and recovery (Nelson and Erlewine 2012). These other factors include changes to the food web structure, an increase in water temperature, reductions in turbidity, and physical landscape changes. They claim a unilateral approach to managing flows without addressing environmental stressors will not reduce the threats to species survival and recovery.

CDFW acknowledges addressing flows alone is not enough to protect pelagic species and support beneficial uses of water. CDFW also acknowledges that addressing food web structure, water temperature, turbidity, and physical landscape changes are important in restoring the health of the Bay-Delta ecosystem. The timing, magnitude, quality of flows through the Delta, and water diversion methods all influence habitat features such as temperature, turbidity, transport, nutrient loadings, pollutant dispersal, and other factors (CDFG 2010b). The influence of these other factors on species abundance is as difficult to address, if not more so than addressing flows. Although important, considerations of these other factors are outside the scope of the Bay-Delta proceedings and deserve to be addressed through separate proceedings where they can be addressed comprehensively. CDFW's Delta outflow recommendations have not changed with the new information in regards to the protections of pelagic species or that the focus of these proceedings should be squarely focused on flows.

Turbidity and Delta Smelt

Scientific consensus supports the association between turbidity and the presence of delta smelt. It is endemic to the upper San Francisco estuary, a critical estuarine habitat which includes low salinity and turbid waters. Deterioration in much of the estuary in the condition of abiotic habitat conditions, especially salinity and turbidity, is a potentially important factor for survival of juvenile and maturing delta smelt (Feyrer et al. 2011).

Latour (2012) found that turbidity has a stronger statistical relationship with delta smelt abundance than has flow. Latour (2012) states that flow by itself has less meaning than other factors such as turbidity. Latour's conclusion is that an outflow objective alone will not increase delta smelt abundance.

Turbidity can be a relatively unmanageable variable while flow is directly manageable through water operations criteria. Specifically, CDFW's recommended X_2 objective places delta smelt and other smelt species ideally in natural sources of turbid waters in Suisun Bay during April through July (CDFG 2010b). Feyrer et al. (2011) described the effect of given X_2 values on the quantity and quality of habitat available. The size and location of this habitat is sensitive to outflow. For example, a downstream location further enhances the turbidity component via wind-wave re-suspension in the shallows of Suisun Bay. For species in which abundance is more highly correlated with turbidity than with flow or salinity, the relationship between abundance and outflow may not be linear. The 2010 CDFW Flow Report states that extremely high outflow events can carry juvenile delta smelt downstream out of rearing habitats in the west Delta and Suisun Bay and into San Pablo Bay. Also, the direct loss of adult delta smelt to entrainment at the CVP and SWP project export facilities is affected by OMR negative flows. In February 2013, export pumping was curtailed by the requirements of the 2008 USFWS BO when adult delta smelt were found to be entrained at the export pumps and salvaged in greater numbers than normal for that time of year when they followed a plume of turbid water generated from early seasonal storms (USFWS 2013). This suggests that reducing exports during periods of high outflow after a "first flush" event could minimize future occurrences of salvage and thus improve delta smelt abundance (Grimaldo 2009). To the degree management of flows can control the location and timing of other factors such as turbidity and salinity, outflow remains relevant to the protection of estuarine species, including delta smelt.

Water Temperature

In the 2010 CDFW Flow Report, CDFW recommended that Delta Outflow for fall X_2 (September through October) be maintained at 74 or 81 kilometers following wet or above normal water years respectively to achieve the quantity and quality of habitat for delta smelt. A wet year in fall 2011 achieved the specified fall X_2 requirement through water operations requirements by the USFWS and NMFS BO. This appears to have resulted in a relatively strong fall 2011 abundance and spring 2012 larval production compared to other wet years (e.g. 2006) when X_2 was maintained higher than 74 kilometers.

In their comments, DWR expressed concern that adopting a fall X_2 objective may affect their ability to meet temperature requirements in upper tributaries, concluding that limits of water storage for meeting both objectives and feasibility of delivering water at existing demand will prevent a fall X_2 objective from be meaningful (Stein 2012b). Current CalSim-II modeling outputs using monthly storage values show significant conflicts between water export supply and the ability to provide water for fall X_2 objectives.

As mentioned in our October 24, 2012 Workshop 3 letter (CDFG 2012c), CalSim-II is a monthly model so biological requirements of instantaneous high or low flows are not captured in the model design. Although CalSim-II and CalLite are valuable tools for water resource planning purposes, they do not have sufficient resolution for operational needs of determining the volume, magnitude, frequency, duration, timing, and rate change of flows to optimize releases for water temperature requirements. The State Water Board should carefully look at the design goals of the models used and determine whether they are of sufficient resolution to determine their applicability to meet water quality objectives. Constraints on a model's ability to predict are not the same as operational or feasibility constraints. Also, the "Major Assumptions" in the "No Action Alternative Simulation (With Fall X_2)" used in the CalSim-II modeling results no longer apply. The hydrograph from 1922–2003 simulation period is not consistent with the hydrograph altered by the operational requirements of the USFWS and NMFS BO. Insufficient data from this new hydrograph requires the model outputs to be validated (Bourez 2012b). Oroville and SWP pumps which were previously used to operate as a surplus delivery system are now operated as the SWP's backbone for water supply reliability. The assumption of existing demand is no longer valid as the USFWS and NMFS BO requirements virtually eliminated the demand for crop idling water transfers (DWR 2009). If a fall X_2 outflow standard would interfere with the temperature standards, the State Water Board should use or develop a model that will consider all the likely inputs and provide the appropriate outputs before concluding whether operating goals are feasible or not. Presumably, meeting an outflow objective and temperature objective should be feasible since the Delta and its tributaries have historically supported delta smelt and spring-run Chinook salmon (*Oncorhyncus tshawytscha*).

Predation

Alteration and management of the Delta's hydrograph has resulted in areas of artificial lake-like habitat populated by piscivorous largemouth bass. The abundance of this habitat may influence fish predation. Workshop comment letters by the fish agencies did not address predation to a notable extent because the influence is extremely uncertain. To address the uncertainty and mitigate the problem, the fish agencies support research, monitoring populations of predatory fish, and increased harvest of certain managed non-native piscivorous fishes.

With the following notable exception, stakeholder presentations and written comments to the State Water Board did not focus on predation. In their September 14, 2012 Workshop 2 letter, SJTA made several comments concerning predation that warrant close evaluation because they are either misconstrued, inaccurate, or are unsupported assertions implying certainty where none exists.

For instance, SJTA asserts that in a 2011 CDFW Staff Proposal (CDFG 2011b) to the Fish and Game Commission for Striped Bass (2011 Staff Proposal):

> *"All fishery agencies have acknowledged that striped bass are a major stressor on Chinook populations in the [Central Valley] and recovery will not occur without significant reduction in their populations and/or predation rates."*[8]

CDFW notes that SJTA's statement is not accurate and finds that nothing in the 2011 Staff Proposal can reasonably support that statement. In its 2011 Staff Proposal, CDFW characterizes the current state of knowledge with regard to the impact of predation on salmonids as follows:

> *"Although the impact of striped bass predation on the listed species is not certain, the Department has evaluated the large body of information and has determined that striped bass predation is an adverse impact, albeit one of unknown magnitude, that can likely be mitigated in part by promulgating a set of regulations that would authorize additional harvest by recreational anglers."*[9]

Furthermore, the 2011 Staff Proposal describes CDFW's position regarding the recovery of listed fishes:

> *"[t]he decline of listed species occurred only after striped bass had been established in California for many decades and the SWP and CVP were substantially implemented, which, given the timing and rate of development (e.g., water, timber, agriculture, roads, industry, etc.) in California, suggests the species could co-exist in a future where the impact of development was effectively mitigated."*[10]

Thus, the passages from the 2011 Staff Proposal demonstrate that SJTA cannot plausibly contend that CDFW has determined that recovery of Chinook populations will not occur without significant predator control.

Moreover, SJTA's letter also states as follows:

> *"A lawsuit by the Coalition for a Sustainable Delta against [CDFW] was settled in April 2011. Under the Settlement… [CDFW] must make*

[8] Demko et al. 2012b, p.15
[9] CDFG 2011b, p.24
[10] CDFG 2011b, p.23

appropriate changes to the bag limit and size limit regulations to reduce striped bass predation on the listed species, develop an adaptive management plan to research and monitor the overall effects on striped bass abundance, and create a $1 million research program focused on predation of protected species."[11]

SJTA has misunderstood the terms of this settlement. The settlement only required CDFW to carry out the research program and to submit a proposal to the California Fish and Game Commission to change fishing regulations.

In addition, SJTA asserts that Porter (2011) concluded that the

"Columbia River predator suppression program has cut predation on juvenile salmonids by 36%."[12]

This is a misstatement. Due to system complexity and a paucity of data, it is not possible to attribute changes in young-salmon survival rates to the program. The following passage from Porter (2011) accurately describes findings of the program, which has been in continuous existence for roughly 20 years and has resulted in the removal of three million pikeminnow:

"The 2011 estimated reduction in potential predation was estimated at 36% of pre-program levels."[13]

CDFW believes the report appropriately used the qualifying terms "estimated" and "potential" and therefore, SJTA's assertion overstates the findings in Porter (2011).

Lastly, SJTA's letter states that:

"[t]he overwhelming majority of predation on juvenile Chinook is the result of nonnative predators that were intentionally stocked by [CDFW], and whose abundance can be reduced to minimize the impacts on Chinook" and claims that "[r]educing striped bass predation on juvenile Chinook is the simplest, fastest, and most cost-effective means of increasing outmigration survival."[14]

CDFW notes that there is no data to support either of these statements. Based on concerns raised by interested parties throughout the San Joaquin River basin, CDFW conducted an analysis of available data and provided comments in our February 7, 2011 submittal to the State Water Board (CDFG 2011a). The following is a relevant excerpt from that submission:

"This lack of a discernible controlling relationship [of striped bass on SJR

[11] Demko et al. 2012b, p.41
[12] Demko et al. 2012b, p.15
[13] Porter, R. 2011, p. 8
[14] Demko et al. 2012b, p. 40

salmon] is not surprising since predation is a long term natural ecological process and that predation of [San Joaquin River] juvenile salmon occurs by vectors including birds, mammals, and fish other than striped bass. Basic ecological principles lead to an assumption that in a system containing multiple predators, such as the Delta, the removal of one predator will be replaced by another. There is evidence for this ecological principle in the SJR basin from large scale habitat restoration projects conducted on the Tuolumne River (TID 2000) where the highest numbers of smallmouth bass occurred at sites with the lowest numbers of largemouth bass. In this system, predation occurs by both native (pike minnow) and non-native fish species and has occurred historically, occurs now, and will continue in the future. Since striped bass and SJR salmon have already co-existed for more than a century in this system, most any perturbations from its introduction should have already been muted by the adjustment by other predatory species. Similar findings of relationships between striped bass and Sacramento fall-run Chinook salmon abundance are also found when considering the existing data (Nobriga and Feyrer 2008, Lindley et al. 2009).

As the Department has previously demonstrated, juvenile salmon production, not predator abundance, is controlling SJR salmon production. The more that tributary and in-delta nursery and out-migratory corridor habitat conditions are favorable to juvenile salmon production, the greater the number of adult salmon produced. We have shown that late-spring flow magnitude, duration, and frequency are intricately tied to improved juvenile salmon rearing conditions and population abundance."[15]

Also, in 2011, the USFWS provided the State Water Board with a summary of ways that flow creates suitable conditions for juvenile salmon production (USFWS 2011), stating:

"*Flow reduces predation on juvenile salmonids via several mechanisms. Increased flow increases suspended sediments (turbidity) reducing a predator's ability to visually locate prey (Rodríguez and Lewis 1994; Gregory and Levings 1998). Increased flow can speed migration rates of juvenile salmonids (BPNWL, 1995), reducing the time spent in areas with high predation mortality. Higher flows can inundate historical floodplain habitats, providing both a refuge from predators and increased food resources for juvenile salmon (Figure 4.7). Increased food can increase growth and larger juveniles are better able to avoid predators (Jeffres and others 2008). Additionally, increased flows from the tributaries can reduce the available habitat for predatory fish such as striped bass that prefer warmer water, and also reduce their metabolic (and feeding) rates (Kruger and Brocksen 1978).*"[16]

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[15] CDFG 2011a, pp. 15-16

16 United States Department of the Interior. 2011, pp 36-37

III. Other Recommendations and Technical Information

Invasive Species

In our August 16, 2012 Workshop 1 letter, we explained the importance of a natural flow regime for the control of invasive species within the Bay-Delta estuary (CDFG 2012a). Invasive species threaten the diversity and abundance of California native species as well as create human health and safety issues and negatively impact the state and local economies (CDFG 2008). Appendix A of this attachment is a supplement to CDFW's Workshop 1 letter as it includes additional information concerning invasive species, specifically an analysis of the environmental parameters that contribute to the successful establishment of invasive quagga and zebra mussels and which California water bodies may be more vulnerable to mussel establishment based on these parameters. CDFW recommends the State Water Board use this information, along with water quality data and hydrodynamic models, to 1) determine which locations within the Bay-Delta estuary are most vulnerable to invasion by quagga and zebra mussels, and 2) determine what flow management and other management responses can be utilized to prevent their introduction or control their spread should they become established in the estuary in the future.

Non-flow related parameters

Non-flow related parameters such as non-native species, habitat loss, and pollutants also affect ecosystem heath and fish abundance, however, these can be addressed outside of the Bay-Delta Plan proceedings through processes, such as the Bay Delta Conservation Plan (BDCP) Program of Implementation and the Regional Water Quality Control Boards' (Regional Water Boards) Basin Plans, which are better suited to address these non-flow related issues.

BDCP Program of Implementation

The BDCP is DWR's plan to minimize the impacts of the state and federal water projects. The design of alternate conveyance facilities will be set based on the flow criteria established by the update of the Bay-Delta Plan. This in turn will determine the level of habitat restoration to occur and the water needed to maintain these new habitats. CDFW is fully engaged in providing technical expertise to see that this project will meet the needs of fish and wildlife.

Regional Basin Plans

Water quality is generally a local issue and the Regional Water Boards' Basin Plans are the master water quality control planning documents. The Regional Basin Plans set water quality standards and implement regulatory programs such as Total Maximum Daily Loads, National Pollution Discharge Elimination System, and Waste Discharge Requirements to meet water quality objectives and support beneficial uses. The Triennial Review process offers the best opportunities to properly scope these water quality problems and frame their solutions.

Adaptive Management

Key issues in determining whether adaptive management should be undertaken are 1) whether there is substantial uncertainty about the impacts of management, 2) whether there is a realistic expectation of reducing uncertainty at an appropriate time scale compared to management decisions, and 3) whether opportunities to adapt in response to new information exist such that the reduction of uncertainty can be expected to improve management (Doremus 2012; Williams 2011). With respect to implementation of revised flow objectives, the first condition clearly exists, and the second condition seems likely to exist provided the monitoring and special studies program is designed well and adequately funded. The third condition, concerning opportunities for adjustments, is more problematic. For example, if reliability of water diversions is a goal, the flexibility to manage adaptively may be significantly constrained (National Research Council [NRC] 2011, 2012). The ability to implement management experiments to address key uncertainties, adapt in response to new information, and how such adaptation will be accomplished warrants thoughtful consideration and a clear description of how it will be addressed.

Adaptive management is defined in the 2009 Delta Reform Act as *"a framework and flexible decision-making process for ongoing knowledge acquisition, monitoring, and evaluation leading to continuous improvements in management planning and implementation of a project to achieve specified objectives."*[17] The structured decision-making process used in adaptive management, involving articulation of objectives, identification of management alternatives, predictions of management consequences, recognition of key uncertainties, and monitoring and evaluation of outcomes, is what differentiates it from a trial and error approach (i.e., try something, and if it does not work, try something else) (NRC 2004; Williams 2011). Through an adaptive management approach, understanding of both the resource and its management can be enhanced over time.

A key attribute of adaptive management is the identification and reduction of uncertainty, where possible (Allen et al. 2011). Williams (2011) describes four kinds of uncertainty that can influence the management of natural resource systems:

- **Environmental variation** is often the most prevalent source of uncertainty, and is largely uncontrollable and possibly unrecognized. It may have a dominating influence on natural resource systems, through such factors as random variability in climate.
- **Partial observability** refers to uncertainty about resource status. An example being the sampling variation that arises in resources monitoring.
- **Partial controllability** expresses the difference between the actions targeted by decision makers and the actions that are actually implemented. This uncertainty arises when indirect means (e.g., regulations) are used to implement an action (e.g., setting a harvest or productivity rate), and it can lead to the possible

[17] California Water Code §85052

misrepresentation of management interventions and thus to an inadequate accounting of their influence on resource behavior.

- **Structural or process uncertainty** arises from a lack of understanding (or lack of agreement) about the structure of biological and ecological relationships that drive resource dynamics.

CDFW anticipates that the approach identified in Appendix K – Revised Water Quality Control Plan of the *Public Draft Substitute Environmental Document in support of potential changes to the Bay-Delta Plan: San Joaquin River Flows and Southern Delta Water Quality* (State Water Board 2012) provides a potential template for what may be proposed with respect to adaptive management for Phase II – the remainder of the Bay-Delta Plan focused on fish and wildlife beneficial uses. The draft language contained within the Revised Water Quality Control Plan stipulates that a process will be established to allow for adaptive management, within certain bounds, of the flow regime to meet the water quality objectives. In its submittal to the State Water Board, dated August 16, 2012, responding to workshop questions for the Bay-Delta Workshop 1, CDFW summarized essential elements of an adaptive management framework and resources available to guide development of such a framework. The following information is meant to build on that earlier submittal.

The Revised Water Quality Control Plan (State Water Board 2012) stipulates that "*…State Water Board staff will work with the COG [Coordinated Operations Group] and interested persons to develop procedures for an adaptive management process, to be submitted for approval by the Executive Director within one year following the date of OAL's [Office of Administrative Law] approval of this amendment to the Bay-Delta Plan.*"[18] Given the complexity and level of effort associated with developing a science-based, workable adaptive management program, CDFW recommends that this design step not be delayed until after OAL approval of the revised Bay-Delta Plan. A critical initial step is identifying and engaging the appropriate stakeholders, and then working with those stakeholders to strive for agreement on scope, objectives, and potential management actions (e.g., means of implementing the flow objectives) (Williams et al. 2009). CDFW recommends that the State Water Board convene a process involving the relevant stakeholders to initiate this planning process. Furthermore, CDFW recommends that the State Water Board consider the three-phase (nine step) adaptive management process described in the Final Draft Delta Plan (Delta Stewardship Council 2012) as an organizing framework for the adaptive management process it develops and implements.

The Revised Water Quality Control Plan (State Water Board 2012) allows for adjustments to the percentage of unimpaired flow (+/- 10 percent). However, constraining the extent to which flow can be modified in this manner may inhibit the ability to implement management actions/experiments designed to address key uncertainties regarding the role of flows and other factors in protecting public trust resources. An independent scientific review of the Vernalis Adaptive Management

[18] State Water Board 2012. Appendix K, p.4

Program (VAMP), conducted by Dauble et al. (2010), noted this constraint in the following statement:

> *"In establishing flow objectives for any future VAMP experimental design for adaptive management investigations, it makes sense to deliberately include more frequent flows at the higher target levels (5,000-7,000 cfs with HORB [Head of Old River Barrier] in place, or 6,000 - 10,000 cfs with no HORB in place) whenever possible. VAMP flows generally have been too restricted in range and have included more low flows than high flow. From an experimental or adaptive management perspective, it is impossible to learn much about effects of higher flows without having a chance to observe survival (and carry out acoustic tagging experiments) at such higher flows."*[19]

In addition, the draft language in the Revised Water Quality Control Plan (State Water Board 2012) stipulates as follows: *"[a]ny adaptive management plan that would modify the total quantity of flow over the entire February through June period must be agreed to by all members of the COG prior to submitting it to the Executive Director."*[20] Given past experiences, such a requirement (agreement by all parties) is likely to stifle opportunities for implementing management experiments and adapting in response to improved understanding. An alternative approach would be to treat consensus as an overarching goal of the COG, but provide a dispute resolution process as a means of moving forward in instances where consensus cannot be reached. CDFW suggests incorporating language to the effect that in instances where a management action(s) contained within the adaptive management plan is intended to benefit or may negatively affect a sensitive species and/or its habitat, the Executive Director will consult with the regulatory agency (director of CDFW and/or regional director of NMFS or USFWS) with jurisdiction over that species prior to making a determination regarding approval of the plan.

Structured decision making has been identified as one method to overcome management paralysis and mediate multiple stakeholder interests (Allen et al. 2011). Structured decision making is best used to identify and evaluate alternative management actions by engaging stakeholders, experts, and decision makers in the decision process and addressing the complexity and uncertainty inherent in such efforts in a proactive and transparent manner (Allen et al. 2011). Clearly defined objectives, explicit acknowledgement of uncertainty, and responding transparently to all stakeholder interests in the decision process are key drivers associated with success of the structured decision making process (Allen et al. 2011). The NRC's (2012) report on *Sustainable Water and Environmental Management in the California Bay-Delta* highlights four approaches that provide structured, transparent procedures for decision-making and rationalization of decisions in complex situations (refer to Appendix F). Decision-support tools, such as those described by the NRC (2012), are likely to have great utility during this process, given the complexity of the issues being addressed and

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[19] Dauble et al. 2010, p.9

[20] State Water Board 2012. Appendix K, pp.4-5

the diverse interests of the stakeholders.

Ultimately, the roles and responsibilities of the entities responsible for implementing the adaptive management program need to be clearly defined. A lack of leadership for the complex process of implementing an adaptive approach has been identified as a main factor contributing to widespread difficulties implementing adaptive management (Walters 2007). In addition, there is a need for a dedicated, highly skilled agent (person, team, office) that is responsible for assimilating knowledge acquired through the monitoring and special-studies program, as well as other relevant sources, and making recommendations to decision makers regarding programmatic changes (Dahm et al. 2009). The efforts of such an agent will be carried out on a continual basis, but over a range of time scales (e.g., daily, yearly, or decadal) depending on the nature of the adaptive management action. A related component is the need to define a sustainable finance structure capable of fully funding implementation of the adaptive management program, including the monitoring and special-studies program, over the long-term.

Independent expert review of the adaptive management program, prior to initial implementation and at regular intervals (e.g., every five years) thereafter, will help to ensure that the program is of sufficient scientific quality to serve its intended purposes. The Delta Independent Science Board may be an appropriate entity for such a review, given the requirement that they provide oversight of scientific research, monitoring, and assessment programs that support adaptive management of the Delta through periodic reviews of each of those programs[21].

It is worth noting that much work has been done and is currently on-going with respect to the topic of adaptive management within the Delta and supporting watersheds. For example, an adaptive management program is currently being implemented for fall outflow (USBR 2012b), pursuant to the requirements of the 2008 USFWS BO. In addition, adaptive management is being incorporated into a number of current planning efforts, including the review and update of San Joaquin River flow objectives (State Water Board 2012), Delta Plan (Delta Stewardship Council 2012), Bay Delta Conservation Plan (BDCP), and FloodSAFE (a planning project led by DWR). It will be important to seek opportunities to integrate these efforts to the full extent practicable.

IV. Closing Comments

Flow objectives should be the focus of the Bay-Delta Plan update as there are no other processes that can effectively address the issue of proper allocation of the state's water resources for use within the Delta. Ensuring sufficient freshwater flows that mimic the features of a natural hydrograph is essential to a functioning estuarine ecosystem. Many species depend on these flows especially those whose populations are threatened or endangered. As natural flows and the patterns of those flows have been reduced or altered, ecosystem productivity and species and habitat diversity in the Delta has diminished. With reliance on current scientific information and new understanding

[21] California Water Code §85280(a)(3)

of Delta ecosystems and species, CDFW believes that this update of the Bay-Delta Plan will be a keystone that sets California on a path to a functioning Delta ecosystem while ensuring a reliable water supply. CDFW looks forward to being an active partner in the effort to update and implement the revised Bay-Delta Plan.

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Appendix A – Invasive Species

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